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Annual Report
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AIR QUALITY
BALMERTOWN

ANNUAL REPORT, 1975

H. D. Griffin
Chief, Air Quality Assessment

TECHNICAL SUPPORT SECTION
NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

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CONTENTS

SUMMARY 1

INTRODUCTION 3

VEGETATION AND SOIL ASSESSMENT
- (a) Forest Areas
  - (i) Observation Plots 4
  - (ii) Fume Damage 5
  - (iii) Chemical Analysis 6
- (b) Planted Roadside Trees 8
- (c) Vegetable Gardens 8

SNOW SAMPLING 9

AIR MONITORING
- (a) Dustfall 9
- (b) Sulphation Rate 10
- (c) Source Monitoring Survey 10
  - (i) Suspended Particulate 11
  - (ii) Sulphur Dioxide 11
  - (iii) Mercury 12

ACKNOWLEDGEMENTS 12

FIGURES AND TABLES 14-32

SUMMARY

This report presents an evaluation, with historical comparisons, of Ministry of the Environment air quality studies in the Balmertown area in 1975. The industrial sources of air pollutants in the area were roasters operated by two gold mining firms situated in close proximity to one another.

Evidence concerning the effects of roaster emissions on local environment was obtained from vegetation, soil and snow assessment surveys and from air monitoring investigations.

Until 1973, forest vegetation near the mines displayed symptoms of severe arsenic and sulphur dioxide injury. Following the installation of pollution control equipment at the larger mine (Campbell Red Lake Mines Limited), a very significant reduction in arsenic-related injury was noted in the 1974 growing season. This improvement continued in 1975 and was accompanied by a concomitant decrease in arsenic levels in plant foliage. Close to the smaller mine (Dickenson Mines Limited), arsenic injury also declined in 1974 and 1975, but the arsenic content in vegetation remained well above desirable levels. In 1976, however, arsenic levels should decline further as a result of abatement of arsenic emissions from Dickenson. Vegetation damage caused by sulphur dioxide has been observed near both mines since 1972, the first full year of investigation. In 1974 and 1975, sulphur dioxide injury extended over 60 to 70 hectares, and about 15 percent of this area contained damage classed as severe. Foliar sulphur levels were elevated in the injury zone.

The arsenic content in forest soils near both mines remained at excessive levels in 1975, and significant improvement is not anticipated for several years. There was no evidence of airborne contamination of soils by iron, lead or mercury.

Trends found in forest areas were confirmed by sample results from street trees and vegetable gardens in Balmertown. The data suggested, however, that Dickenson Mines continued to be

a significant source of airborne arsenic in 1975. In vegetable gardens, all samples but one yielded arsenic levels below the criterion established by the Canada Health Protection Branch. Arsenic concentrations in residential lawn and garden soils remained high.

Snow samples revealed the presence of an area near the mines contaminated by arsenic, iron and sulphate. The location and extent of this zone was similar to that determined from vegetation and soil surveys.

Measurements of total dustfall in Balmertown gave inconclusive results. However, the soluble arsenic content of dustfall was highest at the stations closest to Dickenson. Sulphation rates were highest at monitoring points most influenced by downwind conditions from both mines. The Ontario ambient air criterion for sulphation rate was exceeded twice in 1975. A sulphation plate survey near both mines showed that highest rates occurred in the area where vegetation injury was most pronounced.

Suspended particulate downwind of both roasters contained much less arsenic in 1975 compared with 1971. Sulphur dioxide concentrations, however, had not decreased and frequently exceeded the Ontario standard for extended periods in July, 1975.

Significant levels of airborne mercury were detected at the Red Lake Golf and Country Club, and the source was traced to golf course greens. The Ontario standard for mercury was not exceeded.

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INTRODUCTION

For over 25 years, Campbell Red Lake Mines Limited and Dickenson Mines Limited have employed a roasting process to extract gold from arsenopyrite ores at their mine sites at Balmertown in the Red Lake area of northwestern Ontario. Waste gases from roasting were vented to atmosphere and contained quantities of arsenic, sulphur dioxide and iron. Abatement measures were undertaken first in early 1974, when Campbell installed a baghouse to control arsenic emissions. In June, 1975, Dickenson replaced their old 27 metre roaster stack with a new one 49 metres in height. A baghouse control system at Dickenson is scheduled for start-up during the summer of 1976.

To assess the effects of contaminants in roaster stack emissions on the surrounding area, Ministry of the Environment began air quality investigations in late 1971. Soil samples were collected in the Balmertown area in October, 1971, and an expanded vegetation and soil sampling program was carried out in 1972 and 1973.

In 1974, survey work was expanded to include snow sampling. The number of vegetation and soil sample points was also increased from 10 to 16, and trembling aspen observation plots were established at all sites.

The first air monitoring in Balmertown and vicinity was carried out in October, 1971, using mobile instrumentation for the measurement of sulphur dioxide and suspended particulate. A permanent sulphation station was established in early 1973. In the following year, a dustfall jar was added at this site and three additional dustfall/sulphation monitoring points were selected in the town area.

In the 1975 program, the snow sampling survey was increased to 20 sites. The vegetation and soil assessment program was also substantially increased to provide 24 stations, most of which were close to the two mines. Nine of the 16 observation plots established in 1974 were maintained in 1975, and trees in these plots were assessed for diameter and height growth, crown condition, and the

presence and identity of injury caused by insects, diseases or air pollutants. To supplement the four-station air monitoring network in Balmertown, sulphation plates were set out during July and August at 10 sites near the mines. Data on sulphur dioxide, arsenic and mercury levels were also collected from July 12 to July 25 by the air monitoring van from Air Resources Branch, Toronto.

VEGETATION AND SOIL ASSESSMENT

(a) Forest Areas

(i) Observation Plots

Sixteen trembling aspen plots were established in the spring of 1974. Each plot consisted of the first 20 living aspen trees encountered in a strip 2 metres wide. Minimum acceptable size was 2 centimetres dbh (diameter breast height). Plot size varied considerably, depending on stand density. Trees were assessed using a crown classification system developed by the Canadian Forestry Service. This system ranked trees into several classes according to evidence and extent of crown dieback. At Balmertown, trees were evaluated three times during each of the 1974 and 1975 growing seasons. Table 1 summarizes results up to the end of September, 1975. Most trees (over 80 percent) were apparently healthy, about 15 percent showed slight to advanced dieback symptoms, and 3 percent had died. The greatest incidence of dieback was recorded at plot 5, about mid-way between the two mines. Crown class changes in 1974 and 1975 are noted in Table 2. The few changes observed could not be related to effects of roaster fumes.

Tree diameter measurements taken at the end of the 1973, 1974 and 1975 growing seasons are summarized in Table 3. Within 1000 metres of both mines (plots 1, 5, 6 and 9), diameter growth averaged 5.8 percent over the 1974-75 period, much less than the 12.5 percent average achieved by the two control plots. This difference might indicate adverse effects from arsenic and/or sulphur dioxide fumigations, but might also reflect differences in local climatic,

site or stand density factors. An example of the latter was noted at plot 6, where a very large diameter growth rate was measured. This unusual increase was attributed to the effects of removal of all surrounding trees in late 1974, which promoted accelerated growth in 1975.

Heights of all trees in all plots averaged 7.6 metres. Height growth measurements were not sufficiently sensitive to indicate a trend over a short-term period.

The only specific disease conditions noted on plot trees were two leaf spot infections caused by *Marssonina populi* and *Ciborinia whetzelii*. The former fungus occurred on all trees in plot 5 in 1974, but was absent in 1975.

Nearly all aspen trees were affected to some degree by insect attack, but most foliage (80 percent) suffered only trace to light damage. Most injury was caused by the forest tent caterpillar (*Malacosoma disstria*) and there was no evidence of differences in infestation severity with distance or direction from the gold mines.

(ii) Fume Damage

Fume damage has been noted on vegetation near the mines in every year since survey work began (1972). In 1972 and 1973, typical, acute arsenic and sulphur dioxide injury was observed on vegetation near the mines and in the residential area of Balmertown. In 1974, arsenic injury was much reduced and symptoms ascribed to this pollutant were confined to a small area east and southeast of Dickenson Mines. This improvement reflected benefits from the installation of arsenic emission controls at Campbell. Most observed vegetation injury was caused by sulphur dioxide, and the area affected in 1974 was estimated at 60 hectares. No injury was seen in the town area. In 1975, arsenic injury symptoms had disappeared, except for a few small trembling aspen trees about 250 metres southeast of Dickenson. This further improvement probably resulted from roaster shut-down at Dickenson from the beginning of the growing season until June 25, when the roaster was reactivated and waste gases were

discharged through a taller stack. The distribution of sulphur dioxide injury differed in 1975 and 1974 (see Figure 1), but the area was about the same (66 vs. 60 hectares). Most of the damage occurred in July and August. The severity and extent of symptoms indicated the effects of short fumigations containing high gas concentrations. About 15 percent of the sulphur dioxide injury was classed as severe. Many species of trees and shrubs were damaged, including trembling aspen, white birch, balsam poplar, speckled alder, beaked hazel, and mountain ash. Of these, mountain ash was the most resistant.

Except for a few trees on the northern fringe of Balmertown, vegetation in the town area was free of injury symptoms.

(iii) Chemical Analysis

Chemical analysis of plant foliage and soil collected near the Balmertown gold mines in 1972 and 1973 demonstrated the presence of a zone contaminated by arsenic. Arsenic concentrations decreased with increasing distance from roaster stacks. All evidence supported the conclusion that arsenic contamination resulted from airborne deposition and not from naturally-occurring arsenic in soil parent material. The arsenic content of forest vegetation decreased sharply in the 1974 growing season, following the implementation of abatement measures at Campbell's roasting operation. In a small area east of Dickenson, arsenic contamination in vegetation was still well above desirable levels. Arsenic content in forest soils did not change appreciably between 1973 and 1974.

In 1975, triplicate samples of trembling aspen foliage were collected from 24 sites (Figure 2) in June and September. Surface soil (0-5 cm) was sampled at the same locations in September, and all material collected was analysed for arsenic, sulphur, iron and lead content. In a separate survey, trembling aspen and soil (0-5, 5-10 cm) was obtained from nine points close to the two mines and submitted for mercury analysis.

Results of arsenic, iron and sulphur determinations are summarized in Table 4. Arsenic levels in aspen foliage were highest

to the east of Dickenson Mines and decreased with distance from the roaster stack. An exception was site 18, where an anomalous high value was found. Omitting the value for site 18, the remaining data were grouped into five classes for preparation of a contour map (Figure 3). This map was based on a SYMAP computer program, developed by Harvard University. Arsenic levels in vegetation and soil exhibited different distribution patterns. A soil contour map (Figure 4), again deleting site 18, showed that the most heavily contaminated soils occupied an area between the two mines. Since arsenic concentrations in soil change slowly with time, the soil contour map is probably a fair representation of the historical deposition of arsenic emitted by the two stacks.

Iron content in vegetation followed about the same distribution pattern as arsenic, indicating Dickenson's roaster stack as the principal source. With the exception of the value for site 6, iron levels were not considered excessive. As expected, iron in soil showed no evidence of gradient with distance from either source. The natural background levels of iron in soil masked any evidence of aerial deposition.

The concentrations of sulphur in aspen foliage revealed a different distribution pattern then that for either arsenic or iron. The highest values were northwest of Campbell, and southwest and southeast of Dickenson. Sulphur levels gradually decreased with distance in all directions from both sources. The sulphur content of soil was low and no gradient was apparent. Lead levels were uniformly low in both vegetation and soil. Mercury concentrations were also very low in vegetation (< 0.5 ppm) and soil (< 1.0 ppm).

Trends in arsenic contamination are summarized in Table 5. Except for the area immediately east of Dickenson (site 6), there was a pronounced drop in arsenic levels at all locations in 1974, the first season after baghouse controls were installed at Campbell. These reduced levels were maintained in 1975.

(b) Planted Roadside Trees, Balmertown

Foliage from planted Manitoba maple and white elm trees along Balmertown streets was sampled at three sites in September, 1975. Leaves from the sides of trees facing and away from the two mines were analysed for arsenic, iron, sulphur and lead. Arsenic values from triplicate samples from both tree species were averaged and summarized in Table 6, along with comparable data from earlier years. There was a very significant drop in average arsenic concentrations from 1973 to 1974 and 1975, in agreement with sampling results in forest vegetation. The difference between arsenic content in tree foliage facing and away from the sources was maintained for all years, evidence that the contamination was airborne. Highest levels were closest to Dickenson Mines. The increase in arsenic in 1975 over 1974 suggests that periodic fumigations from Dickenson's roaster occurred in the town area. All values were well above those for control samples from Red Lake.

The three street tree sample points were too far from Dickenson to show elevated levels or concentration gradients with respect to iron. Similarly, there was no evidence of differences in foliar iron on different sides of the trees. Sulphur was slightly elevated, compared with controls, but no difference was noted between tree leaves facing and away from the source. Lead concentrations were uniformly low.

(c) Vegetable Gardens

A variety of vegetable crops was sampled in three residential Balmertown gardens. Iron, sulphur and lead levels were usually low and were about the same in Balmertown and Red Lake. Arsenic results are summarized in Table 7 for a 3-year period. The sharp decrease recorded for forest and street tree vegetation in 1974 was also evident in garden plants. There was evidence of a modest increase in arsenic from 1974 to 1975. With the exception of a sample of lettuce leaves from one Balmertown garden, arsenic content of edible vegetables was below the Canada Health Protection

Branch criterion of 2.0 ppm, fresh weight. In contrast, the situation in soils on residential properties remained unsatisfactory in 1975 (Table 8). No significant decrease in soil arsenic is expected for several years.

SNOW SAMPLING

The first snow sampling survey in the Balmertown area in 1974 revealed the presence of elevated concentrations of arsenic, iron and sulphate near the gold mines. An expanded survey in early 1975 confirmed these findings. The most pronounced concentration gradient with distance from source was shown by arsenic. Highest arsenic values were within 500 metres to the northeast, east and southeast of Dickenson Mines. Iron levels were slightly elevated in the same area. The findings indicated that Dickenson's roaster was the source of these two contaminants.

AIR MONITORING

(a) Dustfall

Dustfall and suspended particulate are the most visible kinds of air pollutants. Dustfall consists of larger particles which settle out from the air under the influence of gravity, and is measured by exposing open top vessels of specified dimensions for 30-day periods. The dustfall collected is weighed and results expressed in tons per square mile per month.

Dustfall jars (and sulphation plates) were exposed at four locations in Balmertown in 1975 (Figure 5). Table 9 shows the monthly and annual values obtained. Many results were invalidated because of contamination by organic matter. Several values exceeded the Ontario criterion, but these could not be related to known industrial sources of air pollution. Dustfall was analysed for a 4-month period (March-June) for arsenic content. Highest levels were found in dustfall at station 61011 (closest to Dickenson) followed by 61010, 61012 and 61013. Although arsenic content was

not excessive, the results indicate that Dickenson's plume reached the town area at times during the March to June period.

(b) Sulphation

Sulphation rate is measured by exposing lead dioxide candles or plates of known surface area to the air for 30-day periods. Lead dioxide reacts with atmospheric sulphur compounds to form lead sulphate, and results are expressed in milligrams of sulphur trioxide per hundred square centimetres per day (mg SO_3/ 100 cm^2/day). Although several sulphur compounds may react with lead dioxide, sulphur dioxide is considered to be the sole reactive substance in Balmertown. To obtain a rough estimate of average sulphur dioxide concentrations (in ppm), sulphation rates are multiplied by 0.03.

In 1975, highest sulphation rates were usually found at stations 61010 and 61011, both of which would most frequently be downwind of the roaster stacks (Table 9). The Ontario ambient air criterion was exceeded on two occasions.

Results from 14 sulphation stations in July-August are shown in Figure 6. As anticipated, highest values were recorded closest to the two mines where visible vegetation injury was greatest.

(c) Source Monitoring Survey

An air monitoring survey was carried out in July by a mobile van unit provided by Air Resources Branch, Toronto. Data were collected for comparison with results from a similar survey in October, 1971. Depending on wind direction and accessibility, the van was positioned downwind of the source at the point of expected highest pollutant concentration. Monitoring of gaseous pollutants (sulphur dioxide and mercury) was then carried out for periods of at least 30 minutes. Suspended particulate concentrations were determined with high volume samplers operated for periods varying from 12 to 32 hours.

(i) Suspended Particulate

Suspended particulate constitutes particulate matter of small size (0.1 to 100 µ) which remains in the atmosphere for extended periods. A known volume of air is drawn through pre-weighed glass fibre filters for 24-hour periods and the filters are then re-weighed to determine the quantity of dust collected. Results are given as micrograms per cubic metre of air ($\mu g/m^3$). The Balmertown filters were also analysed to determine the amounts of arsenic, iron, lead and antimony trapped in the particulate.

In 1971, 13 samples of suspended particulate from Balmertown yielded some extremely high levels of arsenic downwind of both gold mine roaster stacks (Table 10). The 1975 survey (Figure 7) produced 41 samples, results of which are given in Table 11. All total suspended particulate measurements were less than the standard of 100 $\mu g/m^3$. Arsenic levels in the second survey were very much lower than those in 1971, and no value exceeded the current standard of 75 µg or the proposed new standard and criterion of 15 and 5 µg, respectively. The highest arsenic concentration recorded was 2.64 $\mu g/m^3$, downwind of Dickenson. Under more stable wind conditions, higher values might have been recorded. Iron concentrations were also within the Ontario standard. Lead and antimony occurred in such small amounts that both were usually not detected in the filters.

(ii) Sulphur Dioxide

Sulphur dioxide was monitored at eight sites (Figure 8). A total of 13 hours, 24 minutes of data was obtained. A summary of readings in Table 12 indicates that concentrations downwind of both roasters exceeded the provincial half-hour standard of 0.3 ppm for extended periods of time. The highest 30-minute average was 0.94 ppm and the maximum peak value was 1.84 ppm (Figure 9). These findings were similar to those reported for the October, 1971 survey where sulphur dioxide concentrations up to 1.90 ppm were monitored during a 4-hour period.

(iii) Mercury

In 1971, significant mercury concentrations were found at two locations at the Red Lake Golf and Country Club. During 115 minutes of monitoring, ambient air concentrations varied from 0.002 to 4.5 $\mu g/m^3$ and averaged about 1.1 µg. The 30-minute standard of 5 µg was not exceeded. At the time of the survey, the source was not clearly established.

In 2 hours, 24 minutes of monitoring on July 16, 1975, elevated mercury concentrations were again encountered on the golf course. Half-hour averages ranging from 0.58 to 2.8 $\mu g/m^3$ were obtained, with a peak value of 5.08 µg (Figure 10). Since all measurements were recorded immediately downwind of three greens, the latter were implicated as the source. It was later learned that mercuric fungicides had been applied to greens in the past to control disease problems. The use of these compounds was discontinued a few years ago.

ACKNOWLEDGEMENTS

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- Air Quality Laboratory, Laboratory Branch, for chemical analysis of vegetation and soil, and for preparing and supplying lead dioxide plates and determining sulphation rates.
- Phytotoxicology Section, Air Resources Branch, for technical advice, for preparing computer SYMAPS and for processing vegetation and soil samples.
- Thunder Bay Laboratory, Northwestern Region, for chemical analysis of snow and for dustfall weight determination and chemical analysis.
- Inorganic Trace Contaminants Section, Laboratory Branch, for chemical analysis of snow.
- Instrumentation Development and Monitoring Unit, Technology Development and Appraisal Section, Air Resources Branch, for conducting air quality surveys in the Balmertown area.

- Industrial Abatement Section, Kenora District Office, for assistance in snow sampling.

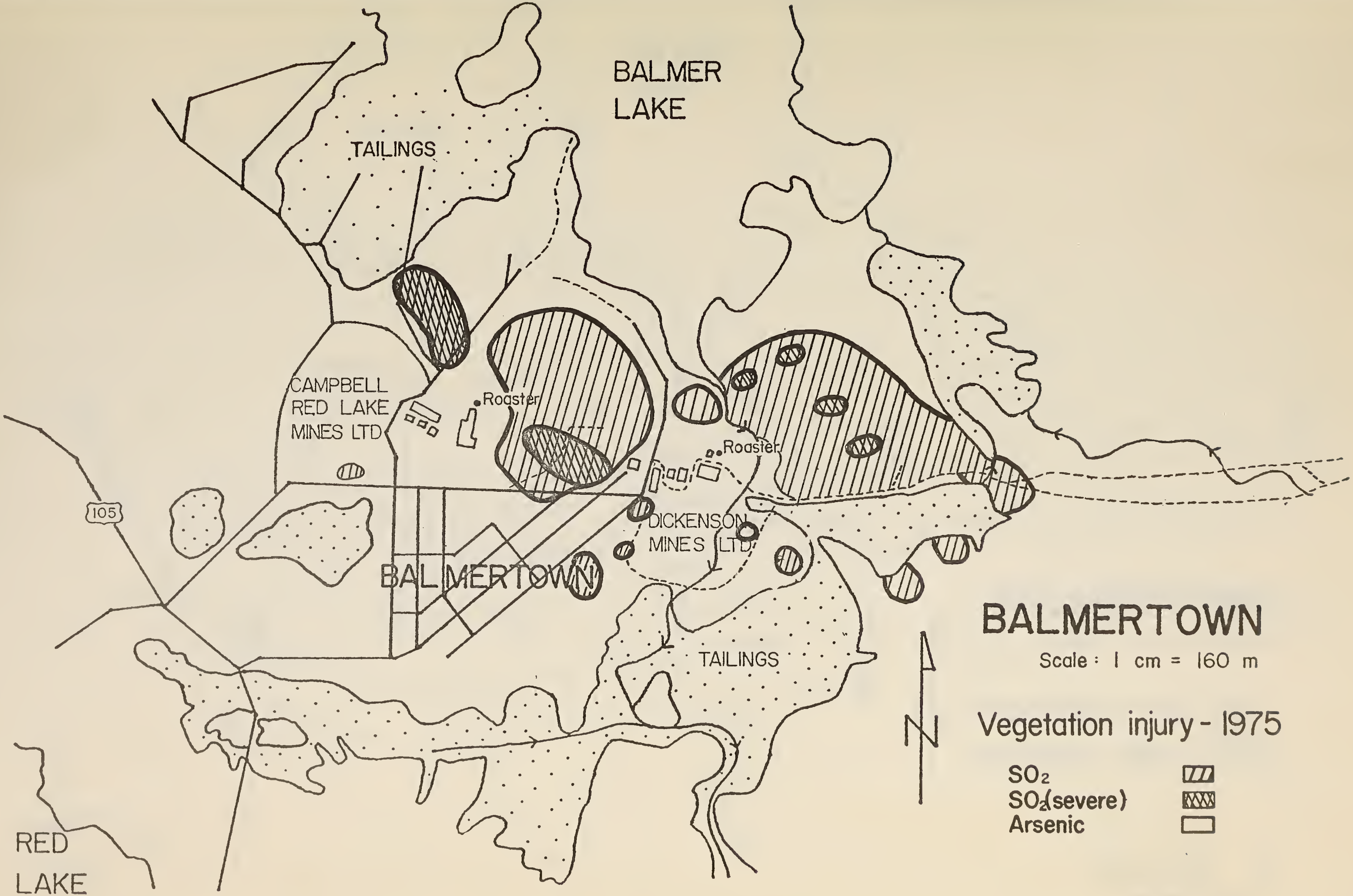
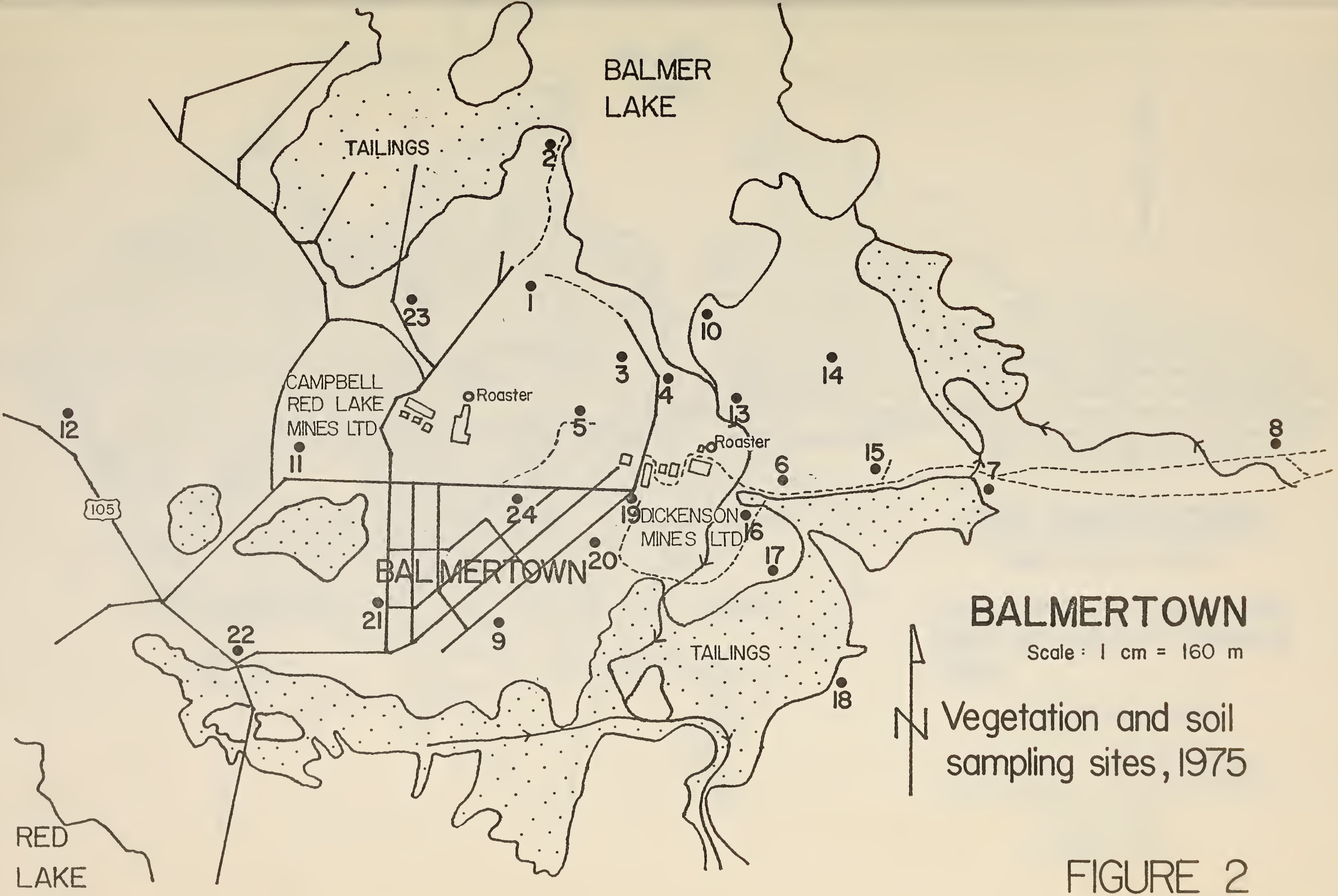

BALMER LAKE
TAILINGS
CAMPBELL RED LAKE MINES LTD
Roaster
Roaster
DICKENSON MINES LTD
BALMERTOWN
TAILINGS
105
RED LAKE
BALMERTOWN
Scale : 1 cm = 160 m
Vegetation injury - 1975
SO2 ▨
SO2(severe) ▩
Arsenic ▭

FIGURE I

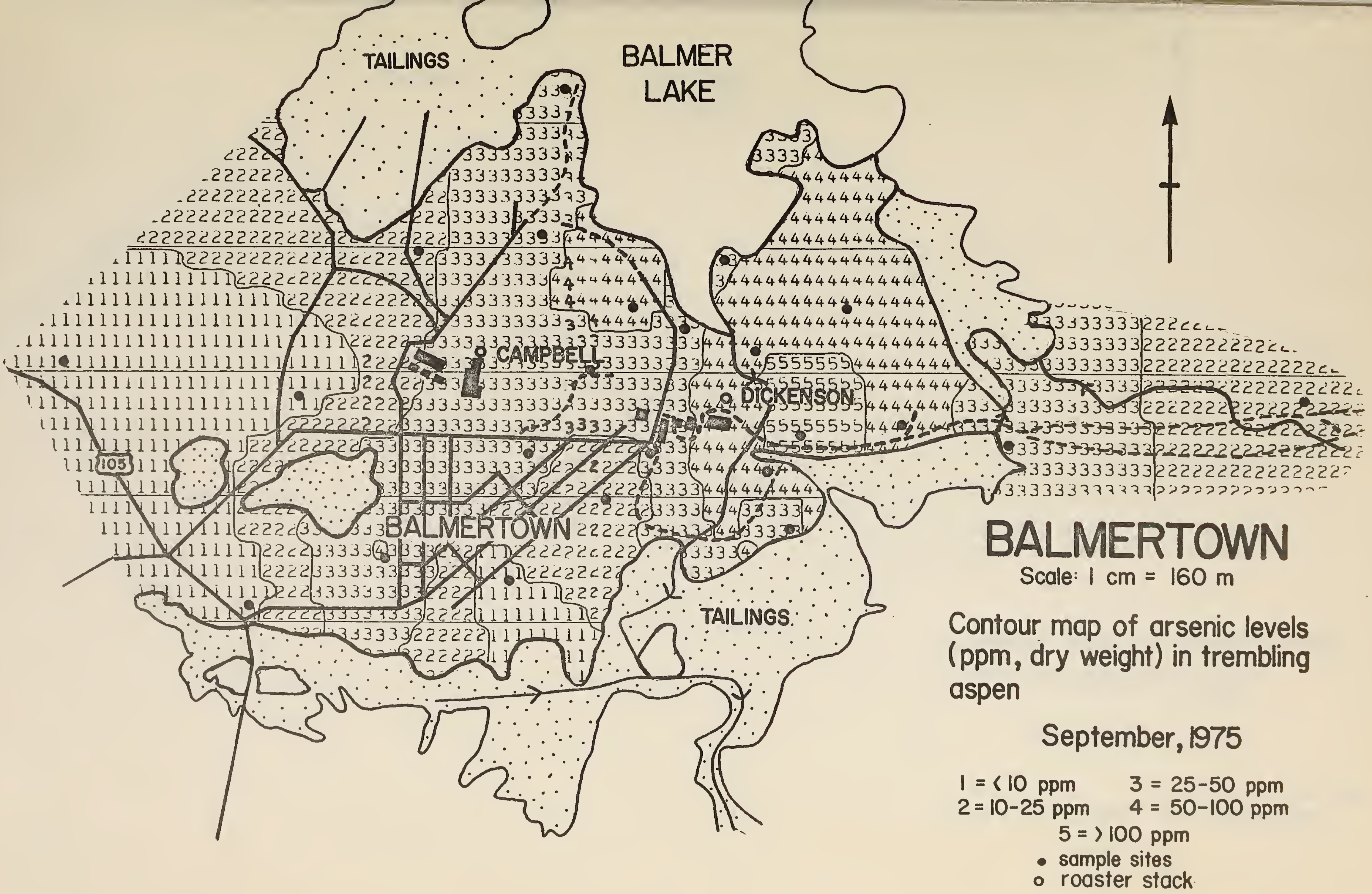


BALMERTOWN

Scale: 1 cm = 160 m

Vegetation and soil sampling sites, 1975

FIGURE 2



BALMERTOWN

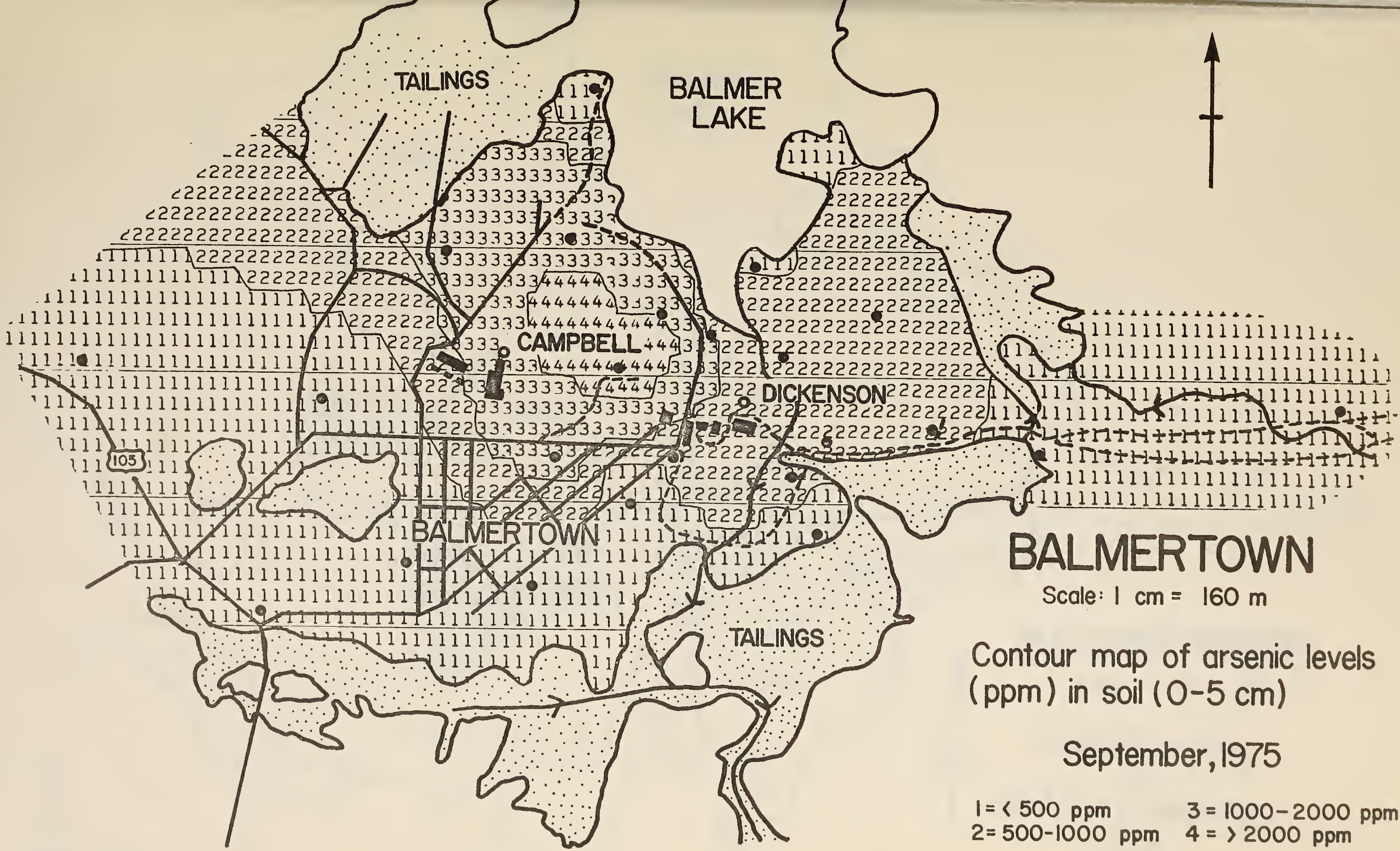
Scale: 1 cm = 160 m

Contour map of arsenic levels (ppm, dry weight) in trembling aspen

September, 1975

1 = < 10 ppm
2 = 10-25 ppm
3 = 25-50 ppm
4 = 50-100 ppm
5 = > 100 ppm
● sample sites
○ roaster stack

FIGURE 3



BALMERTOWN

Scale: 1 cm = 160 m

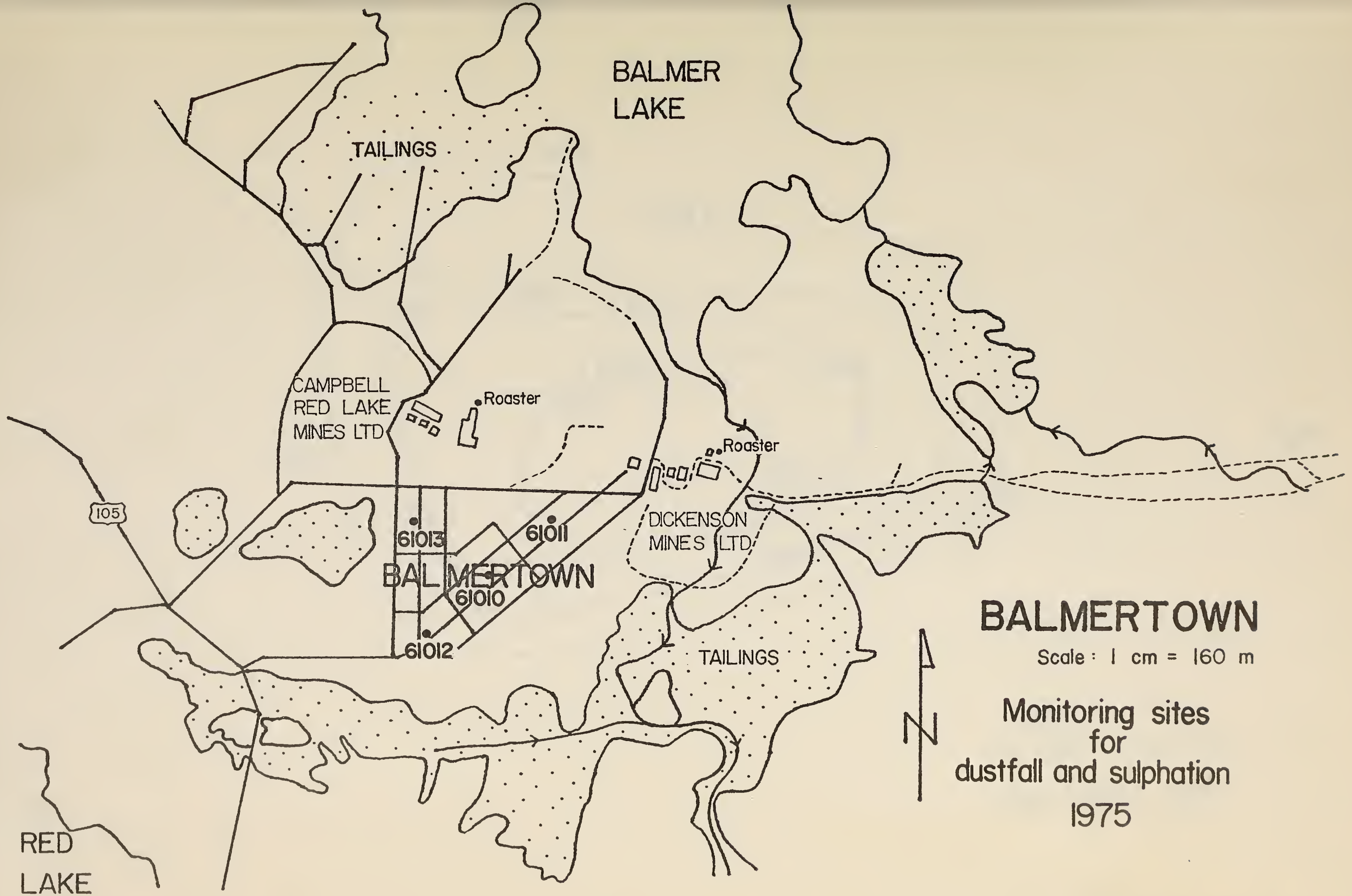
Contour map of arsenic levels (ppm) in soil (0-5 cm)

September, 1975

1 = < 500 ppm
2 = 500-1000 ppm
3 = 1000–2000 ppm
4 = > 2000 ppm

- ● sample sites
- o roaster stack

FIGURE 4

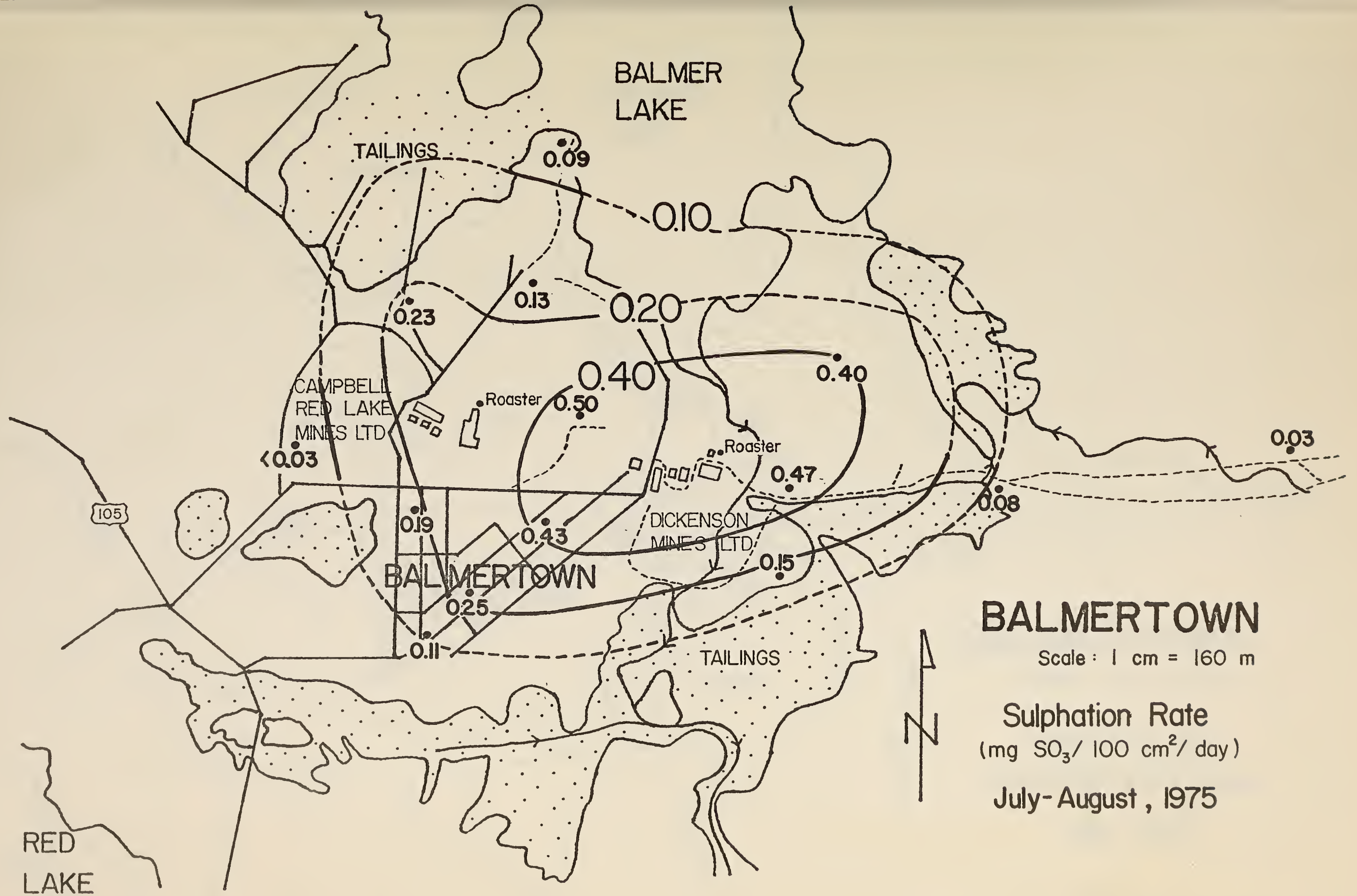


BALMERTOWN

Scale : 1 cm = 160 m

Monitoring sites
for
dustfall and sulphation
1975

FIGURE 5

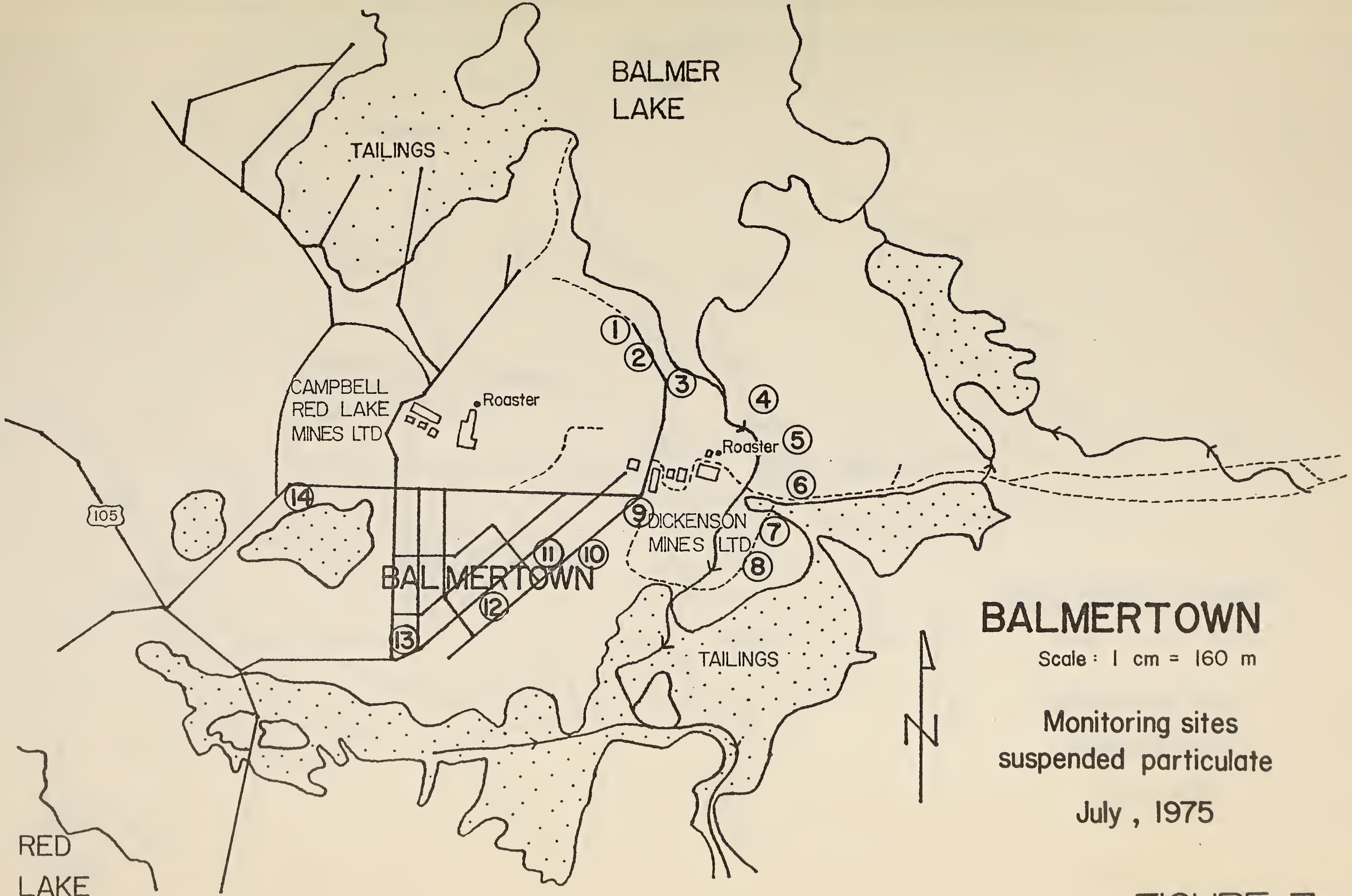


BALMERTOWN
Scale : 1 cm = 160 m

Sulphation Rate
(mg SO_3/ 100 cm^2/ day)

July-August , 1975

FIGURE 6



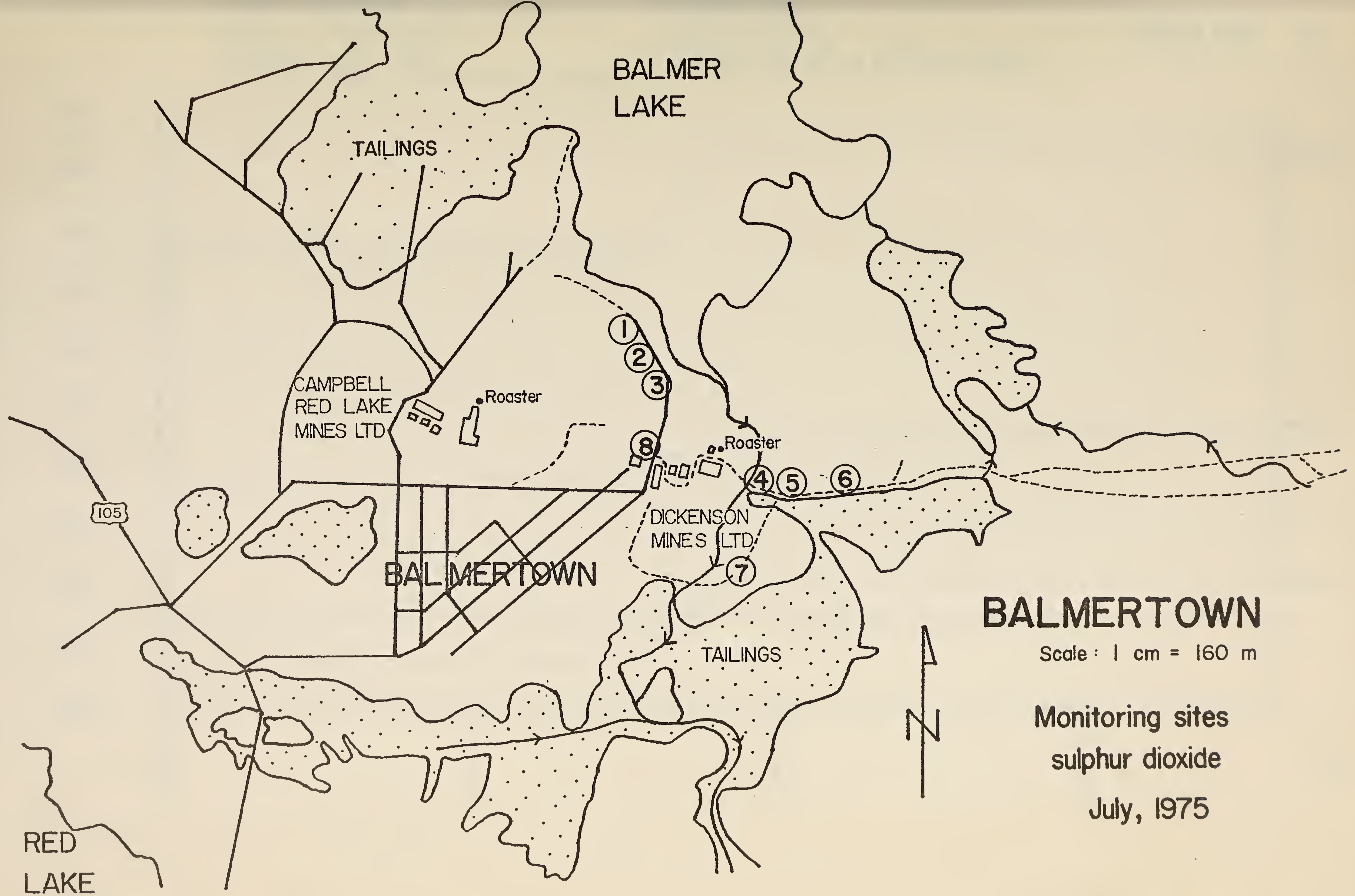
BALMERTOWN

Scale : 1 cm = 160 m

Monitoring sites
suspended particulate

July , 1975

FIGURE 7



BALMERTOWN

Scale : 1 cm = 160 m

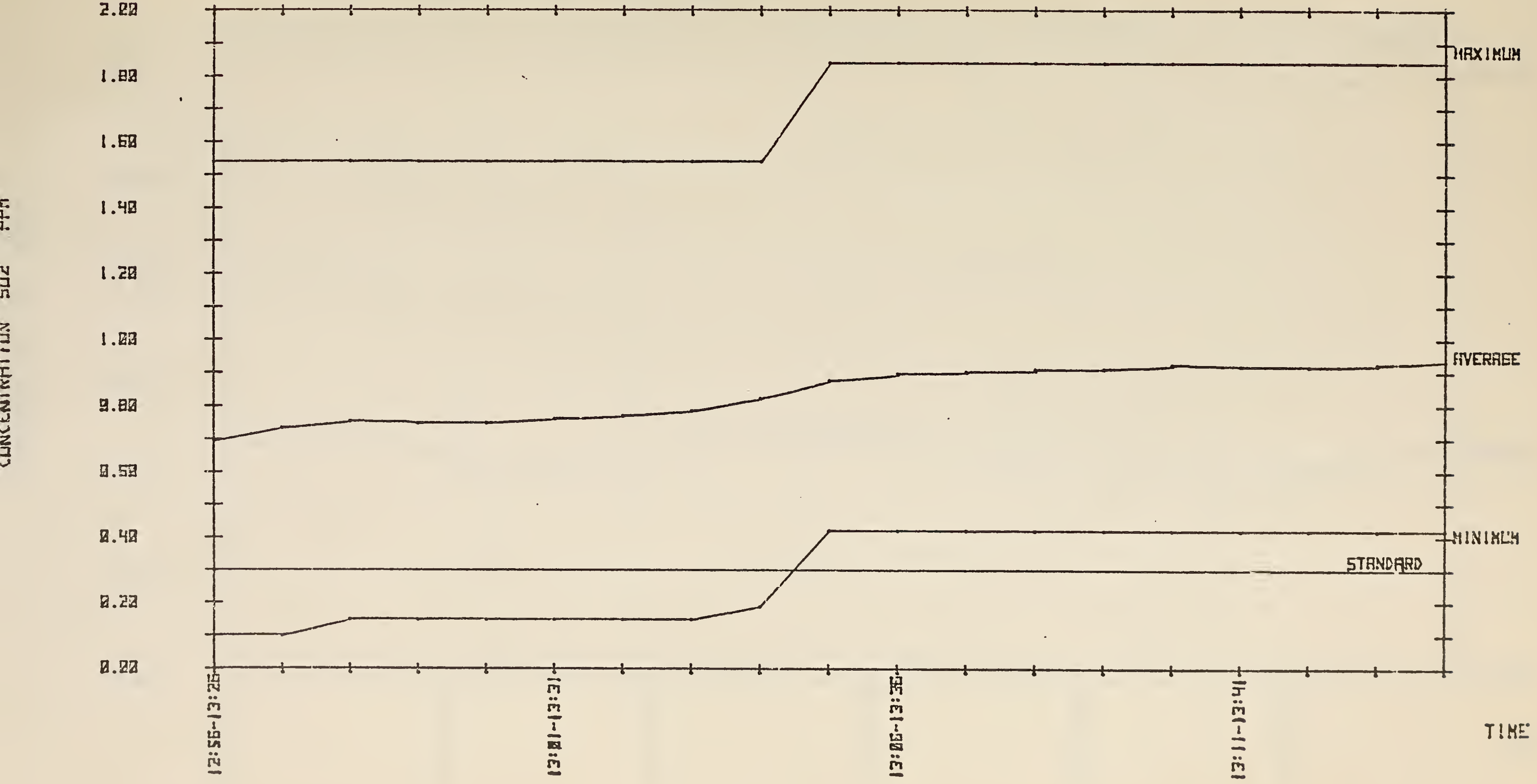
Monitoring sites
sulphur dioxide
July, 1975

FIGURE 8

FIGURE 9

SURVEY: BALMERTOWN I #17
DATE: JUL 18 1975
SCAN TIME: 50 SEC
STANDARD: 0.3 PPM
LOCATION: CAMBELL MINE BY IND. VILLAGE

POLLUTANT: SO2
START TIME: 12:56
AVERAGING TIME: 30 MIN
DISTANCE: 0.56 KM, 45 DEG FROM CAMBELL



SURVEY: BALMERTOWN I #20
DATE: JUL 16 1975
SCAN TIME: 30 SEC
STANDARD: 5 UG/M3
LOCATION: BALMERTOWN GOLF COURSE, GREEN #9

POLLUTANT: HG
START TIME: 12:45
AVERAGING TIME: 30 MIN
DISTANCE: .04KM, 0 DEG FROM SOURCE

FIGURE 10

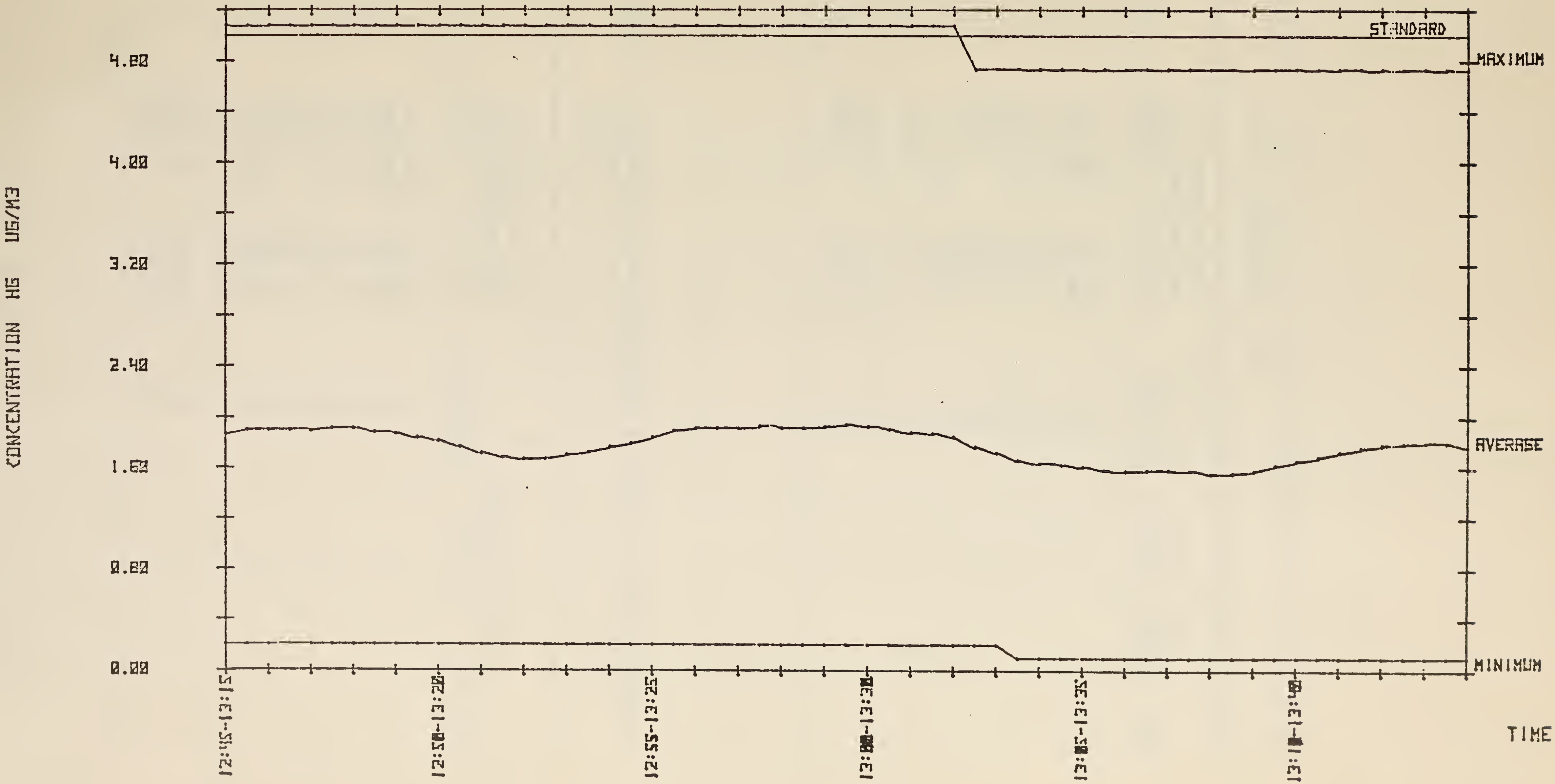


TABLE 1. Crown condition of trees in trembling aspen observation plots, Balmertown, 1975.

	Distance (metres) and direction from					
Plot	Campbell	Dickenson	Apparently healthy	Slight dieback	Advanced dieback	Dead
1	415 NNE	830 NW	17	2		1
2	880 NNE	1150 NNW	16	2		2
5	350 E	480 W	8	11	1	
6	740 ESE	280 ESE	20			
7	1470 E	990 E	15	4		1
8	2670 E	1890 E	16	3	1	
9	720 S	830 SW	17	1	1	1
11	640 WSW	1400 W	15	3	2	
12	1440 W	2225 W	17		2	1
15	27200 SE	(control)	20			
16	12500 S	(control)	20			

TABLE 2. Changes in crown conditions of trees in trembling aspen observation plots, Balmertown, May, 1974 to September, 1975.

	Distance (metres) and direction from		Crown condition		
Plot	Campbell	Dickenson	Unchanged	Improved	Declined
1	415 NNE	830 NW	17		3
2	880 NNE	1150 NNW	14	2	4
5	350 E	480 W	18	2	
6	740 ESE	280 ESE	20		
7	1470 E	990 E	18	2	
8	2670 E	1890 E	17		3
9	720 S	830 SW	18	1	1
11	640 WSW	1400 W	18	2	
12	1440 W	2225 W	19		1
15	27200 SE	(control)	20		
16	12500 S	(control)	20		

TABLE 3. Diameter growth of trees in trembling aspen observation plots, Balmertown, 1973-1975.

Plot	Distance and direction from		Dbh (centimetres) Average of 20 trees/plot			Growth	
	Campbell	Dickenson	1973	1974	1975	cm	%
1	415 NNE	830 NW	3.9	3.9	4.1	+0.2	5.1
2	880 NNE	1150 NNW	5.8	5.7	5.8	nil	nil
5	352 E	480 W	4.3	4.3	4.4	+0.1	2.3
6	740 ESE	280 ESE	2.7	2.8	3.1	+0.4	14.8
7	1470 E	990 E	6.1	6.2	6.3	+0.2	3.3
8	2670 E	1890 E	8.9	9.0	9.2	+0.3	3.4
9	720 S	830 SW	5.6	5.7	5.7	+0.1	1.8
11	640 WSW	1400 W	5.3	5.4	5.5	+0.2	3.8
12	1440 W	2225 W	7.8	7.9	8.1	+0.3	3.8
15	27200 SE	(control)	4.2	4.6	4.9	+0.7	16.7
16	12500 S	(control)	3.8	3.9	4.1	+0.3	7.9

TABLE 4. Levels of arsenic, iron and sulphur in not washed trembling aspen foliage and surface soil, Balmertown, September, 1975.

	Distance (metres) and direction from		Concentrations (ppm, dry weight)			
			Trembling aspen			Soil (0-5 cm)
Site	Campbell	Dickenson	Arsenic	Iron	Sulphur	Arsenic
10	850 ENE	510 N	45	280	3100	406
13	960 E	200 NE	75	410	4800	968
14	1200 E	500 NE	65	270	3900	662
6	740 ESE	280 ESE	257	2300	4700	799
15	1310 E	500 E	70	240	4500	850
7	1470 E	990 E	29	230	3600	168
8	2670 E	1890 E	18	130	2600	435
16	1010 ESE	290 SSE	78	620	5300	717
17	1150 ESE	465 SSE	45	240	4700	297
18	1470 SE	900 SSE	156	705	5000	2973
19	640 ESE	305 SW	27	220	5300	760
20	625 SE	500 SW	10	115	4700	271
9	735 S	900 SW	6	110	3100	327
24	370 SSE	670 WSW	49	305	5000	1483
21	670 SSW	1170 WSW	53	255	3000	151
22	1150 SW	1710 WSW	7	65	2300	230
5	350 E	480 W	33	215	4100	3617
11	640 WSW	1400 W	7	100	2900	391
12	1440 W	2225 W	9	85	1700	71
23	400 NW	1140 WNW	20	175	6400	1033
3	480 ENE	510 NW	93	330	4000	1165
1	415 NNW	830 NW	31	190	4300	1937
4	670 E	225 NNW	31	195	4300	553
2	880 NNE	1150 NNW	26	140	4400	191
25	27200 SE	(control)	2	74	1600	18
26	12500 S	(control)	1	62	1500	19

TABLE 5. Comparison between arsenic content in not washed trembling aspen foliage at Balmertown in 1973, 1974, and 1975. (Averages of triplicate samples in ppm, dry weight.)

			1974			1975	
Site	1972	1973	July	Aug.	Sept.	June	Sept.
1	-	-	8	14	26	3	31
2	-	-	9	12	22	2	26
5	155	554	12	29	29	3	33
6	78	404	24	83	196	7	257
7	21	81	11	19	43	1	29
8	-	-	6	8	14	2	18
9	265	407	8	11	19	2	6
11	98	108	5	6	10	2	7
12	27	41	6	8	9	2	9
Controls	< 1	8	< 1	1	3	< 1	2

TABLE 6. Comparison between 1973, 1974 and 1975 arsenic levels (ppm, dry weight) in not washed foliage of planted Manitoba maple and white elm trees, Balmertown. (Averages of triplicate samples.)

Distance (metres) and direction from		1973		1974		1975	
Dickenson	Campbell	Facing	Away	Facing	Away	Facing	Away
525 SW	480 SE	504	323	70	31	138	58
1005 SW	610 S	734	432	36	21	76	46
1090 WSW	430 SW	352	202	20	12	34	18
8000 SW	(control)	19	25	4	-	4	-

TABLE 7. Comparison between 1973, 1974 and 1975 average arsenic levels (ppm, dry weight) in washed vegetables from three Balmertown gardens.

Vegetable		Balmertown			Red Lake		
		1973	1974	1975	1973	1974	1975
Potato	- leaves	-	18	24	-	4	2
	- tubers	-	2	2	-	< 1	< 1
Beet	- leaves	185	8	8	8	< 1	< 1
	- roots	44	3	9	2	< 1	< 1
Onion	- leaves	-	28	-	-	1	-
	- bulbs	-	6	-	-	< 1	-
Lettuce	- leaves	138	9	18	-	2	< 1
Rhubarb	- leaves	299	6	-	7	< 1	-
	- stalks	30	2	-	3	< 1	-

TABLE 8. Arsenic (ppm, dry weight) in surface soil from three residential properties, Balmertown.

Location	1972	1974		1975	
	Garden	Garden	Lawn	Garden	Lawn
Balmertown	165	164	567	153	452
Red Lake	-	10	14	10	10

TABLE 9. Dustfall levels and sulphation rates in Balmertown, 1975.

Station	Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
		Dustfall (tons/sq. mile/30 days)												
61010	Lassie/Dickenson	-	1	8	8	12	13	-	-	16	29	8	4	11
61011	113 Dickenson Road	3	-	25*	19	27	16	-	-	16	-	26	-	19
61012	Fifth/Dickenson	-	-	19	11	43	22	-	12	-	34	-	-	24
61013	273 Fifth Street	2	0	4	9	17	17	-	-	10	23	13	5	10
		Sulphation (mg SO_3/100 cm^2/day)												
61010	Lassie/Dickenson	.36	.24	.41	.64	.51	.23	.29	.21	.83	.48	.27	-	.41
61011	113 Dickenson Road	.42	.29	.78+	.39	.40	.27	.44	.42	.48	.32	.66	.37	.44
61012	Fifth/Dickenson	.29	.15	.28	.19	.23	.17	.14	.08	.50	.40	.19	.15	.23
61013	273 Fifth Street	.18	.14	.17	.22	.26	.19	.03	.35	.22	.27	.25	.12	.20

*Values exceeding criteria of 20 tons (monthly) or 13 tons (annually) are underlined.

+Values exceeding criterion of 0.70 mg are underlined.

TABLE 10. Suspended particulate in Balmertown area, October, 1971.

Distance (metres) and direction from roaster stacks	Date	Wind direction	Monitoring period (hours)	Concentrations ($\mu g/m^3$)	
				Total	Arsenic
				Downwind from Campbell	
525 NW of CRL*	Oct.24	150-180°	2	644	217
			2	380	131
			2	697	359
320 W of CRL	Oct.29	variable, 0-180°	21	181	46
1440 W of CRL	Oct.30	90-135°	2	95	13
			5	52	46
			5½	41	6
				Downwind from Dickenson	
290 W of DM*	Oct.29	variable, 0-180°	1¼	63	1
				107	14
				55	1
			22	94	22
95 N of DM	Oct.29	variable, 0-180°	2	216	66
				144	40

* CRL - Campbell Red Lake Mines Limited.
DM - Dickenson Mines Limited.

TABLE 11. Suspended particulate in Balmertown area, July, 1975.

Location	Distance (metres) and direction from roaster stacks	Dates	Sample number	Concentrations ($\mu g/m^3$)					
				Total		Arsenic		Iron	
				Range	Mean	Range	Mean	Range	Mean
Sites 1-3	400 NW of DM[*] 625 ENE of CRL[*]	July 13-19, 22-26	17	13-75	47	0.02-1.40	0.19	0.2-4.1	1.8
Sites 4-8	325 NNE-SSE of DM 1050 E-ESE of CRL	July 15-19	12	44-92	74	0.48-2.64	1.06	0.4-7.0	3.7
Sites 9-14	320-1360 SW-W of DM 560-880 SE-SW of CRL	July 16-19, 22-26	12	22-99	48	0.02-0.27	0.07	0.1-3.0	1.6

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[*] DM - Dickenson Mines Limited.
CRL - Campbell Red Lake Mines Limited.

TABLE 12. Levels of sulphur dioxide monitored downwind of Campbell Red Lake Mines Limited and Dickenson Mines Limited, July, 1975.

				Concentrations (ppm)			
				30-minute averages		Peaks	
Site	Date	Period monitored	Source	Min.	Max.	Min.	Max.
1	July 12	12:00-12:35	CRL*	0.41	0.45	0.02	1.17
		12:39-13:09	CRL	0.02	0.02	0.01	0.06
	July 18	09:20-10:35	CRL?	0.15	0.47	0.02	0.80
		11:05-11:33	CRL	0.21	0.21	0.03	0.60
		12:56-13:43	CRL	0.73	0.94	0.10	1.84
2	July 12	17:06-17:50	CRL?	0.02	0.06	< 0.01	0.31
	July 13	11:00-11:43	CRL	0.26	0.73	0.06	1.12
3	July 12	13:37-14:44	CRL?	0.13	0.24	< 0.01	0.90
	July 13	12:00-12:35	CRL	0.16	0.24	0.04	0.86
		12:40-13:40	CRL	0.44	0.88	0.04	1.74
		16:11-16:43	?	0.19	0.25	0.04	1.06
4	July 24	12:15-12:44	DM	0.37	0.37	0.23	0.51
5	July 22	16:00-16:42	DM	0.01	0.04	< 0.01	0.34
	July 23	11:53-12:35	DM	0.05	0.11	< 0.01	0.83
		14:26-14:57	DM	0.12	0.15	0.03	1.24
6	July 22	17:00-18:02	DM	0.06	0.14	< 0.01	1.14
	July 23	09:21-10:24	DM	0.10	0.19	0.02	0.80
7	July 14	09:50-10:20	DM?	0.49	0.49	0.03	1.55
8	July 16	12:02-12:32	DM	0.59	0.59	0.27	1.40

*CRL - Campbell Red Lake Mines Limited, DM - Dickenson Mines Limited.

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Ontario, Ministry of the
Environment. Technical Support....

Air quality Balmertown, Annual
report, 1975.

June, 1976, v.p. Nov 35

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TD883.7/B35/A57/1975/MOE
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Balmertown - annual ascw
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